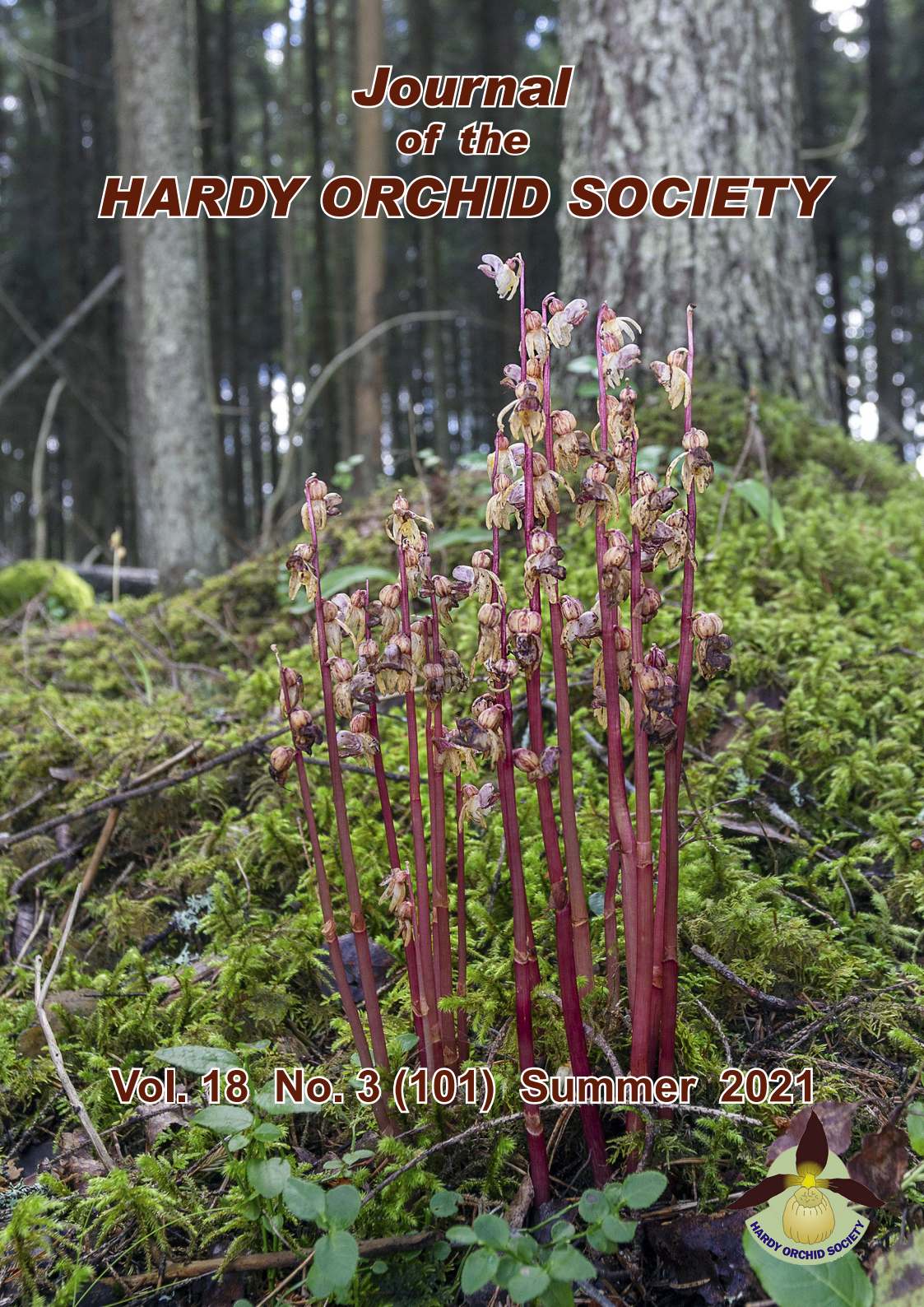
Journal of the HARDY ORCHID SOCIETY



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Some Remarkable Observations of the Ghost Orchid (*Epipogium aphyllum*) in Estonia

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Unprecedented Late Flowering Period

In Estonia the Ghost Orchid *Epipogium aphyllum* is known from approximately 20 locations scattered throughout eastern and central regions, with additional occurrences on the islands of Saaremaa and Hiiumaa to the west. It typically occurs in moist *Picea abies* and *Populus tremula* forests, usually with minimal understorey, growing out of old leaf litter (Fig. 1) but sometimes on green moss (Fig. 2).

Fig. 1: *Epipogium aphyllum* growing out of old leaf litter.
Fig. 2: *Epipogium aphyllum* growing on green moss.

All Photos by Rainar Kurbel

Despite Estonia being one of the coldest countries in Europe away from Scandinavia, the usual flowering period of *Epipogium aphyllum* is similar to that in the rest of its European range, being mid July to mid August, peaking in the second half of July. There are no previous records of Ghost Orchid flowering in May, June, September or October, as with other countries in Europe. It was a great surprise, then, when on 9th October 2020 I discovered two small plants of *Epipogium aphyllum* just coming into bud among colourful autumnal leaf litter (Figs. 3 & 4). They were growing in amongst a large group of Small-leaved Lime *Tilia cordata*, surrounded by English Oak *Quercus robur*, European Ash *Fraxinus excelsior*, European Aspen *Populus tremula* and European Crab Apple *Malus sylvestris*.

The latest recorded flowering of the species in Europe is 17th October, in Oxfordshire, UK (Cole, 2014), so it was clear that these two small plants might create a new record if they were to survive the impending cold period and manage to produce flowers. This is indeed what happened, with the first flower opening on 29th October, by which date six plants had been discovered at the location (Fig. 5)!

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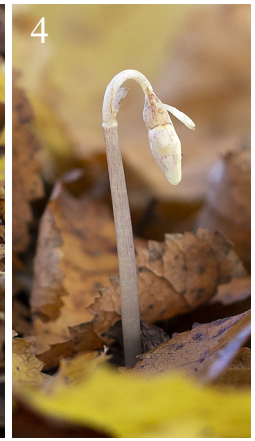

Figs. 3 & 4: *Epipogium aphyllum* coming into bud among autumnal leaf litter.
Fig. 5: First *Epipogium aphyllum* flower opening amongst six plants.

The weather during the interim had minimum temperatures of 1-2°C at night and a maximum of 6-11°C during the daytime, with the 24h average being 6-7°C. The plants were in my experience medium-sized with up to three flowers, reaching 14cm on 29th October, with a stem diameter of 3.5mm, so were no different in size or vitality to those flowering during the usual period.

With temperatures set to drop below freezing in November, it was going to be very interesting to see how the plants fared. Of course, everything lasts longer in a freezer, and during November, temperatures dropped to zero overnight on several occasions, reaching up to 10°C during the day. This didn't affect the Ghost Orchids adversely – in fact, they continued to develop!

One of the plants, with two flowers, was measured at 15cm tall on 1st November, with the top flower still in bud, and by 7th November it was 19.3cm tall with the top bud having now opened. Another stem, with three flowers and with the top flower still in bud on 7th November, opened the third flower on 21st November (Fig. 11). In the interim, one night was -1 to -2°C followed by another at -2 to -4°C, with corresponding daytime temperatures reaching +1°C and +3°C respectively. Subsequently, the weather warmed up, but two stems survived, in flower, until the 9th December. The day before that there was a severe arctic blast (-6.5°C on the night of the 8th December) and the stems broke during the evening of the 9th December, having lost their colouration following the harsh night. This record is remarkable in a number of ways. One open flower lasted 41 days, perhaps the longest of any orchid species anywhere in Europe. The Ghost Orchid can withstand very cold temperatures when above ground, even below freezing for short periods, and a short period of snow does not adversely affect growth.

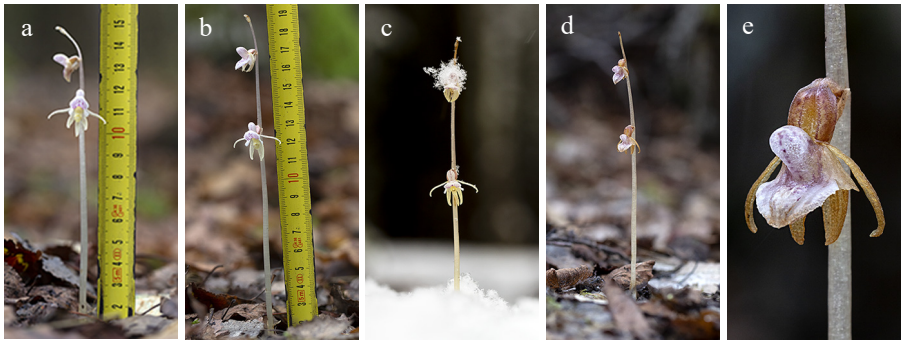

Fig. 6: Lifecycle of an individual *Epipogium aphyllum* plant.

a): First flower opened 29th October and this first photograph was taken on 1st November (height 15cm).
b): Second photograph taken on 7th November (height 19cm).
c): Third photograph with snow taken on 30th November (also on back cover).
d & e) Two photographs taken on 9th December before it fell down on 10th December.
This plant had a flowering period of 41 days and a second plant had flowers open for more than 35 days!

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Slug Predation

Whilst it might have been expected that the temperatures during these plants' emergence would have prevented slug predation, this was not the case. During the early part of emergence, daytime temperatures were reaching up to 10°C and three of the six plants were eaten or broken by slugs between the end of October and mid-November, whilst still in bud. Another three-flowered plant was eaten on 3rd or 4th November. I have recorded a lot of individuals of the non-native species, *Krynickillus melanociphalus* (Fig.7 below) eating *Coprinus* species. It is rapidly expanding in this area since first reported in Estonia in 2014, as are some *Malacolimax* sp. and other smaller slug species. In fact, slug presence and activity was much greater during the period of this observation than during the more usual flowering period of *Epipogium*, in July (and August) – this was especially the case for *K. melanociphalus*.

Fig. 7a: *Krynickillus melanociphalus* eating *Coprinus* sp.
Figs. 7b - 7d: Slug damage to *Epipogium aphyllum* plants.

Underground Parts

One of the plant's stems curled back to meet the ground, forming an arc with the tip of the stem extending below the surface of the leaf litter (Fig. 8). On this plant, flowering commenced at the end of October, but the first open flower quickly fell victim to slugs.

Fig. 8: *Epipogium aphyllum* plant with curled back stem.

Having carefully removed about 6-7cm of upper litter layer in the surrounding area, in an effort to find more flowering plants, I discovered several *Epipogium* stolons with bulbils attached (Figs. 9 & 10). These were 5.4 and 6.2cm apart along the stolon, longer than the 2–3 cm mentioned in the literature (Reinke 1873; Rasmussen 1995, Yagame *et al*. 2007). The bulbil closest to the main rhizome also had smaller rhizoids on it – the very beginnings of newly-developing plants.

The stolons of *Epipogium* are very thin and delicate, breaking even with the most careful movement of the associated leaf litter, or even the slightest accidental contact.

Fig. 9: Stolon of *Epipogium aphyllum* with two bulbils.

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Fig. 10: *Epipogium aphyllum* bulbil with new rhizomes.

These delicate structures are the means by which the species reproduces vegetatively, so it is not difficult to imagine the effect that even the most careful footfall will have on the spread of *Epipogium* among the soft, damp substrates in which it flourishes best. For this reason, sites for this species should not be visited repeatedly or by large numbers of people.

Mycorrhizal Hosts

Several sources (for example, Roy *et al*, 2009) quote fungi of the genus *Inocybe* as the most common mycorrhizal hosts for *Epipogium*. Interestingly, no fungi of this genus were seen in the vicinity during the entire above-ground period of this group of plants. There is the possibility that it was too late for the fruiting period and there were underground parts present, of course.

However, other fungi were present close to these plants, especially several *Coprinus* species (interestingly, this genus is cited as one of the fungal hosts of the other species in the genus, for example *Epipogium roseum*). There were also many *Tubaria furfuracea*, *Hypholoma capnoides* and a colony of *Mucilago crustacea* within a ten metre radius away from the *Epipogium* plants.

Fig. 11: *Epipogium* plants with *Coprinus* sp. very close by on 21st November

***Epipogium* Numbers at a New High Level**

In August 2020 we had the privilege to discover a huge new population of *E. aphyllum* in Estonia. I have been studying orchids in the country for approximately 30 years and this find without doubt gave me one of the biggest "wow" moments in that entire time. To qualify what might sound like an over-statement, I ask you to imagine a football pitch sized area containing exactly 2609 flowering Ghost Orchids! Just to be sure our number was accurate, Toomas Hirse and I counted carefully for exactly six hours non-stop!

In order to protect this incredible colony we will not specify the location, but it is in the eastern part of Estonia. The habitat was middle-age Spruce forest mixed with Pine and Birch. No understorey, with clear visibility through the trees for tens of metres. Nearby some forestry work had been carried out. In August it was very dry there, but under leaf litter and moss there was still some humidity. We discovered other achlorophyllous orchid species there – *Neottia nidus-avis* and *Corallorhiza trifida*, but both were massively outnumbered by *Epipogium*.

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Figs. 12-15: *Epipogium* plants in probably the largest extant population in Europe.

After further visits we found additional plants in the surrounding area, bringing the total number to at least 3000, surely making this the largest extant population of *Epipogium aphyllum* in Europe.

With such a large population as this, it was an opportunity to take some measurements to test the true morphometric range of this species. The maximum number of flowers on a single stem is, from a personal trawl of numerous sources, given as eight to ten. But is this accurate? A plant with ten flowers was reported in 1982 from southwest Germany (P. Delforge, pers. com.). A search of written and electronic media (including internet and social media) has resulted in my finding no records of plants with more than seven flowers, possibly indicating that more vigorous plants were recorded at a time when the species was much more common. But never say never of course.

Fig. 16 One *Epipogium* stem with eight flowers and two stems nearby with seven flowers. Stems with diameter over 8mm are a sign of superb vitality.

It was a great thrill, then, when on 5th August 2020, we discovered a single plant with eight flowers (Fig. 16). Nearby were two plants with seven flowers and many others with five or six. It seems to be that the bigger the population, the exponentially higher the probability of finding highly vigorous plants. In Estonia at least, within smaller populations (up to 10-20 plants) even five flowers on a single stem is rare. In places with just one or two plants usually four flowers is the maximum, but more often just one or two. Width (diameter) of stem (measured at the widest point, usually just above the base) is another indicator of plant vitality. Smaller plants usually have stem widths of 1-2mm, bigger plants with four or five flowers usually 3-4mm. Stems with diameter >5mm are rare. The largest plant we measured in 2020 had a stem diameter of 8.56mm – truly remarkable for *Epipogium*!

Fruit Set and the Size of Fruits

There are many scientific works and books that mention poor or mostly non-existent fruit set of *Epipogium*. This new, large colony changed our perception of this commonly accepted belief. Fruit set rates were surprisingly high, by visual observation a minimum of 80% (Fig. 17), regardless of location within the colony, the size of plants or number of plants in a group. Given the number of flowering plants (2609), this means many thousands of seed capsules, each containing thousands of small seeds approximately 0.2-0.3mm in size. We measured some capsules and they were huge, the biggest ones up to 15mm in diameter, like small cherries!

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Fig. 17 *Epipogium* plants with extensive fruit set.

Weather-related Prediction of Flowering Success

Because of the rarity of *Epipogium aphyllum*, the relevance of weather is a popular topic. Therefore, many search for some logic and try to understand how local climate affects flowering success and thereby determine if flowering is predictable. There are many well-known theories such as warmer spring, enough rainy days in spring (and/or autumn), thunderstorms prior to the flowering period, effect of snow or frost in winter. One thing on which everyone agrees, however, that if there is a long period of drought, immediately prior to the flowering period, *Epipogium* will not flower at all or numbers will be significantly below average.

For any theory to be proven, it would be essential to study multiple populations from a wide geographic spread, in various habitats, altitudes and climates, over a long period of time. In Estonia there are over ten active (i.e. flowering every year) local populations across the country, from the islands of Hiiumaa and Saaremaa off the west coast to eastern and southern areas near the Russian border. Some of them have been studied annually for over 20 years, and others for between five and 15 years. After analysing these data and personal experience it is my opinion, based on Estonian colonies, that there is no connection between climate and flowering success across different populations! Each population lives its own cycle, seemingly unconnected

to that of either neighbouring populations or others elsewhere in the country. To demonstrate this, I chose two pairs of locations close to each other, in different regions: A & B in north-east Estonia and C & D in the south-east of the country (Fig. 18). A & B have the same temperatures as each other throughout the year, the same amount of sun and clouds and the same amount of rain and humidity. The same is true for C & D (distances between these places: A-B=5km; B-C=110km; C-D=33km).

Fig. 18 Location of study sites

As can be seen from the table below, the total number of plants varies consistently with both small differences and more than a ten fold difference (2020 sites C and D). Even if a longer time period is taken into account or more locations are analysed, the result will be same – there is no correlation between populations. If going to one place, you never can predict what will be at another, even one nearby.

	2015	2016	2017	2018	2019	2020
A	19	44	81	22	13	14
B	13	61	78	51	37	37
C	12	0	3	25	6	5
D	19	25	35	17	0	57

After finding the large colony mentioned above we decided to analyse the soil to try to figure out what had created such a dense, healthy colony of *Epipogium*. We collected soil samples from that large colony and five other colonies scattered across the country. All five were chosen with active flowering plants, but in much lower numbers (below 100 stems). Testing was made in a professional Agricultural Research Centre laboratory. Because our investigations are in progress and hopefully will continue in 2021 and beyond, we cannot reach any final conclusions yet. However, initial results showed that in the large colony there is a huge difference in potassium (K), calcium (Ca), boron (B), copper (Cu), magnesium (Mg) and nitrogen (N). Levels of all those elements were between 50% and 500% higher, indicating a correlation between those elements and colony size/health. We plan to do more analysis across further sites on an ongoing basis, as well as co-ordinate a European-wide study to find out whether our initial results are repeated elsewhere. Soil pH in all locations was in the range of 5.5 to 7.4 and in the best places 6.0.

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"Epipogium aphyllum* forma *rosea"

E. aphyllum has only one named variant – the rarely-occuring forma *albiflora* where the flowers lack anthocyanin (red colour), giving the plant an overall transparent whitish to yellowish appearance. In August 2020 we found in one large population two separate clumps of strange-looking plants – even from a distance at first glance they looked different. They were overall "abnormally" reddish among many

Fig. 19 *"Epipogium aphyllum* forma *albiflora"*

"normal" ones, the stems especially, but also the developing fruit capsules. On closer inspection the fruit capsules of the reddish plants had a visibly different shape from all other "normal" ones (see Figure 20). In both "forma *rosea*" clumps (about 50m from each other), most seed capsules were the same, being wider than deep, looking as if two normal capsules were fused together. This shape was not seen on any of the normal plants.

Given how rare this reddish form is, it is difficult to decide whether this is just coincidence or a more consistently occurring phenomenon. It is certainly worth further investigation should more plants of this form be discovered, and subsequently set seed. Maybe therefore, if the yellow form of *Neottia nidus-avis* is called forma *sulphurea*, this reddish form should be called *Epipogium aphyllum* forma *rosea*.

Fig. 20 *"Epipogium aphyllum* forma *rosea "*

Acknowledgement
Special thanks to Toomas Hirse, who has been my partner in countless trips in the field and whose knowledge of habitats and maps is irreplaceable. He has probably seen most Epipogiums in Estonia in different places and discovered new places. Jätka samas vaimus! Thanks also to Sean Cole, who helped with translations into English and added other useful input to this article.

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Front & Back Cover Photographs

Ghost Orchids in Estonia photographed by Rainar Kurbel – *Epipogium aphyllum* forma *rosea* on the front cover and a Ghost Orchid surviving in the snow on the back cover. See the article on page 80.